

# Morphing Theory and Applications to Online Experiments: Learning While Earning

DDTT 2015

Gui Liberali  
Erasmus University



Laboratory for  
Optimization of Digital  
Experiments @ Erasmus



# Morphing



You'll buy more from web ads that know how you think

18:28 07 December 2009 by Vijaysree Venkatraman

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## MIT researchers: morphing Web sites could bring riches

Self-customizing e-commerce sites can expect higher sales, they say

By Tim Greene, Network World, 05/22/2008

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## Tring Web Design

Specialist Web Designers in the Tring Area, Berkhamsted, Bucks

## Website Morphing

- Resources
- cPanel Website Backups
- Creating dynamic PDF files from PHP
- Download Limit Monitoring Using IPCOP
- Encrypt USB drives
- E-Mail Newsletter Design
- Exclude my visits from Google Analytics

Research by M... website, then c... achieved in 10... summaries, in... whether it be t... Hauser Urban



## Websites Morph To Users' Cognitive Styles

Tuesday, June 10, 2008

And we are back.

As you might know, I've been busy for the past two weeks moving to a new home, hence no internet, hence the lack of updates. I'm all set now, and we are back to our usual schedule. I'd never have to deal with so much customer service before in my life, and I have to thank all these people for taking most of the pain of the process.

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I wonder if agents sitting on the front row of desks at a real estate office usually get more walk-in business, and I'm glad one of them did because he found just the one (if you know Cambridge, you know how old and run-down many apartments here are. I'd seen seven of those). Call Apartment Rental Experts on Porter and ask for Paul.

Moving utilities has been a breeze using NStar's website. Comcast continues to provide great service even though they had to send a second technician to fix something that had been overlooked by the first one. It took two business days from the initial call to the technician's arrival.



# One size does not fit all

Appeals to Visual  
Cognitive Style

## Website designs as Morphs

Appeals to Verbal  
Cognitive Style

**Technical Content**

**More Content**

**Visual**

Provider	Price	Speeds	Reliability	Type	Support	Wireless	Contract	Join Filter	Anti Virus	Install Co
BT	£15	256 kb	Great	DSL	Great	Yes	1 year	Yes	Yes	£0
Wanadoo	£15	512 kb	Average	Satellite	Average	Yes	2 year	Yes	Yes	£0
Demon	£17	256 kb	Great	DSL	Great	No	3 year	Yes	Yes	£0
NetService	£22	256 kb	Great	Cable	Good	No	3 year	Yes	Yes	£0
AOL UK	£24	256 kb	Good	Cable	Good	No	2 year	Yes	Yes	£0
Bitx UK	£24	256 kb	Average	DSL	Good	No	4 year	Yes	Yes	£0
Atlix	£29	512 kb	Great	DSL	Great	No	2 year	Yes	Yes	£0
AOL P	£29	512 kb	Good	Cable	Good	No	2 year	Yes	Yes	£0
Star500	£49	256 kb	Average	Satellite	Average	No	4 year	Yes	Yes	£0
Star1000	£49	512 kb	Good	DSL	Average	No	3 year	Yes	Yes	£0

Bar Chart View of selected plans

Provider	Price
BT	15.0
Wanadoo	15.0
Demon	17.0
NetService	22.0
AOL UK	24.0
Bitx UK	24.0
Atlix	29.0
AOL P	29.0
Star500	49.0
Star1000	49.0

**Audio**

**Less Content**

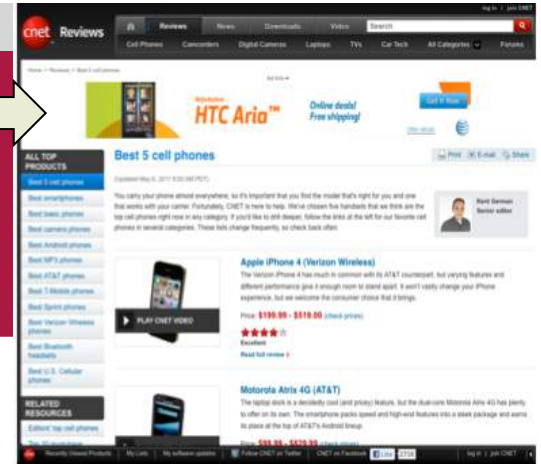
**General Content**

I have been using a computer for as long as I can remember. While a great PC and a fast Internet connection are essential, I have no interest in learning every detail about computers and broadband. AOL, NetZero and BT are the most cost-effective, but NetZero gives the fastest speeds and BT is the most reliable.

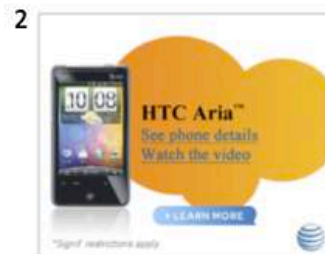
Provider	Price	Speeds	Reliability	Type
BT	£ 15	Average	Great	DSL
Wanadoo	£ 15	Fast	Average	Satellite
Demon	£ 17	Average	Great	DSL

(a) General content, large-load, graphical morph (b) Focused, small-load, verbal morph

# One size does not fit all



## Banners as Morphs



← Appeals to Analytical, deliberative cognitive style



All ads had the word 'refurbished'



← Appeals to Holistic, impulsive cognitive style

# Where's your A/B Testing ?




- From aggregate to disaggregate data
- From demographics to cognitive styles
- From learning-then-earning to the world of learning-while-earning
  - Higher CTR, conversions
  - Better user experience



# 1. Learning about Styles vs Morphs



		Firm Side: <b>Banner Ads</b>			
		<b>Buy!</b> versus <b>Learn</b> <b>More</b>	<b>Inform</b> <b>ative</b>	<b>Emotio</b> <b>nal</b>	<b>Time-</b> <b>pressu</b> <b>re</b>
 <p>Consumer Side: <b>4 Cognitive</b> <b>Styles</b></p>	<b>Verbal-Impulsive</b>	<b>0.1</b>	<b>0.11</b>	<b>0.2</b>	<b>0.13</b>
	<b>Visual-Impulsive</b>	<b>0.11</b>	<b>0.2</b>	<b>0.13</b>	<b>0.1</b>
	<b>Verbal-Deliberative</b>	<b>0.2</b>	<b>0.13</b>	<b>0.1</b>	<b>0.11</b>
	<b>Visual-Deliberative</b>	<b>0.11</b>	<b>0.2</b>	<b>0.13</b>	<b>0.1</b>

# Optimization: from Earn to Learn



- Maximize conversion by picking the best among ads for current user
- If we **knew the conversion** probabilities perfectly we would simply serve the optimal morph
- If we **knew nothing about the conversion** probabilities we would randomize and learn



Need to balance learning the true cognitive style (exploitation) and providing the optimal morph given what we know now (exploration).

For each person!

	Firm Side: Banner Ads			
	Buy! versus Learn More	Inform ative	Emotio nal	Time- pressu re
Verbal-Impulsive	0.1	0.11	0.2	0.13
Visual-Impulsive	0.11	0.2	0.13	0.1
Verbal-Deliberative	0.2	0.13	0.1	0.11
Visual-Deliberative	0.11	0.2	0.13	0.1

# Morphing: real-time adaptation of the firm's actions to each consumer



**Marketing instrument**  
to be adapted  
(morphed)

**Website design, banner, advertising campaign, media copy per channel, promotion, price, product bundle, product recommendation ...**

x

**Consumer latent variable**

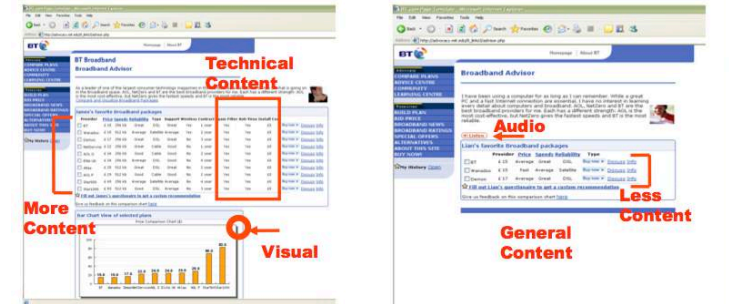
**Cognitive-style, segment, position in the purchase funnel, ..**



# Morphing - Evidences from the Field

## Website Morphing (2009)

- Online sales of BT group's broadband plans can be increased up to 20% by adapting the website to match cognitive styles using our adaptive learning algorithm



## Morphing Banner Advertising (2014)

- Morphing almost doubled click-through rates for context-matched banners (83%,  $p < 0.01$  and 97%,  $p = 0.028$ ) lifts, respectively, for banners and for consumers
- Was *live* on CNET.com (8.4M visitors/day) for a month
- Extends behavioral targeting to avoid local max solutions



## Website Morphing 2.0 (2014)

- NPV reward improvement of 69% over the NPV of the original algorithm; corresponds to \$17.5 million for BT group if implemented
- Proof-of-Feasibility on Suruga Bank
- Generalized version of morphing, including when to morph, switching costs, multiple morphs

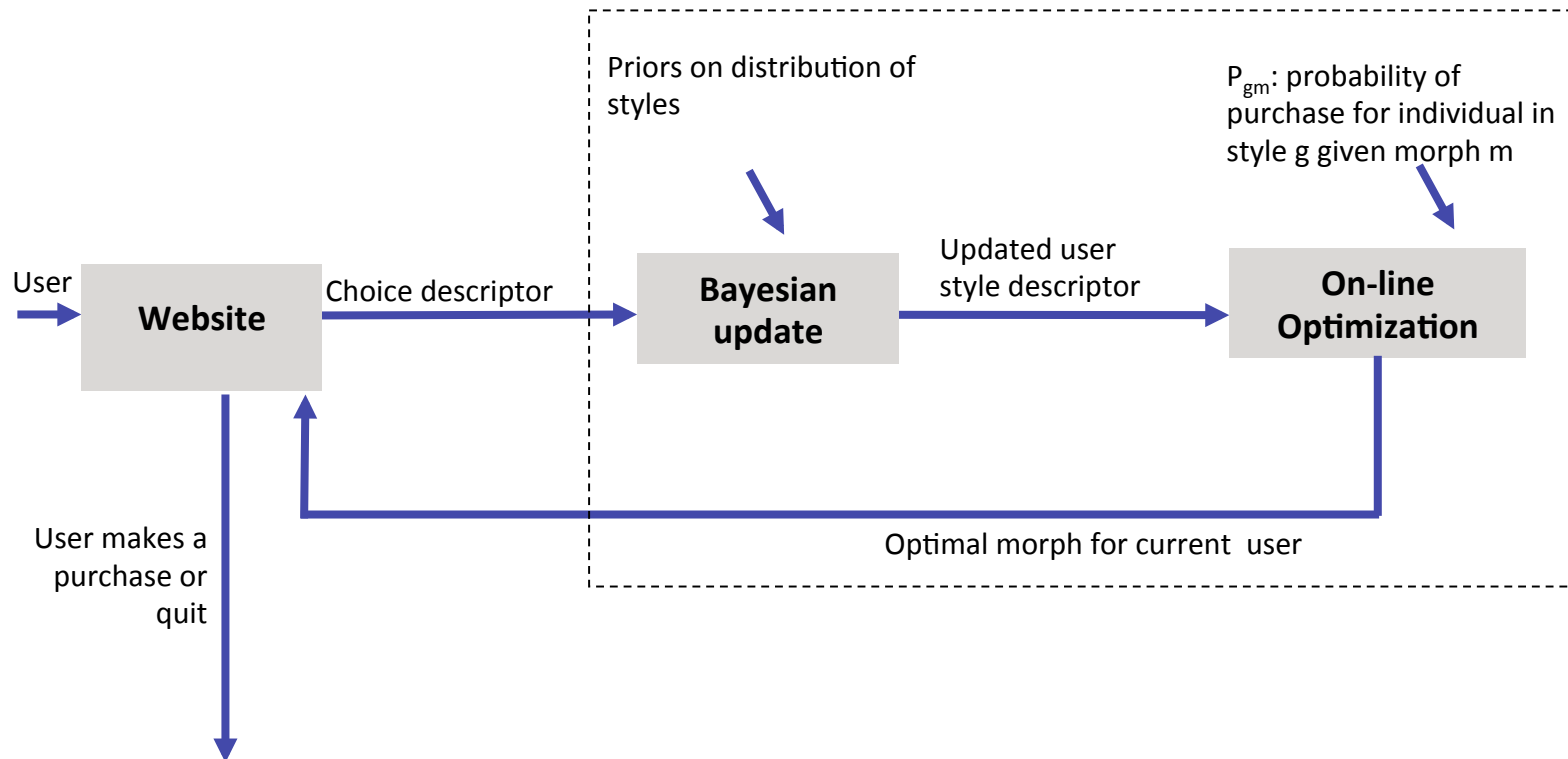


# Morphing Algorithm Challenges Addressed

1. **What is the style of the current user?**
  - Update our beliefs as new clicks become available
  
2. **What is the optimal morph for each style?**
  - Update as we observe successes and failures

		(Verbal_Imp, Visual_Imp, Verbal_D, Visual_D)	Firm Side: <b>Banner Ads</b>			
		( 0.65, 0.15, 0.1, 0.1 )	Buy! versus Learn More	Inform ative	Emotio nal	Time- pressu re
Consumer Side: <b>4 Cognitive Styles</b>	<b>Verbal-Impulsive</b>	0.1	0.11	0.2	0.13	
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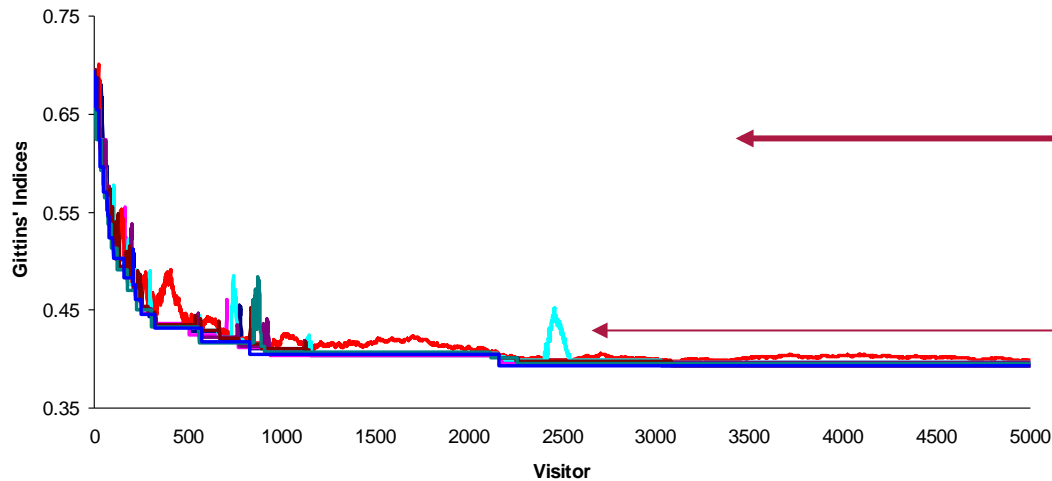
# Morphing



Illustrative example

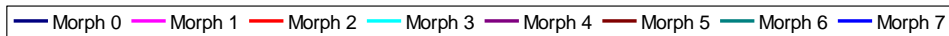
		Banner Ads ->			
		1	2	3	4
Cognitive Style	Impulsive				
	Deliberative	0.1	0.11	0.2	0.13

# Optimal solution with Gittins' indices (assume we know cognitive style)

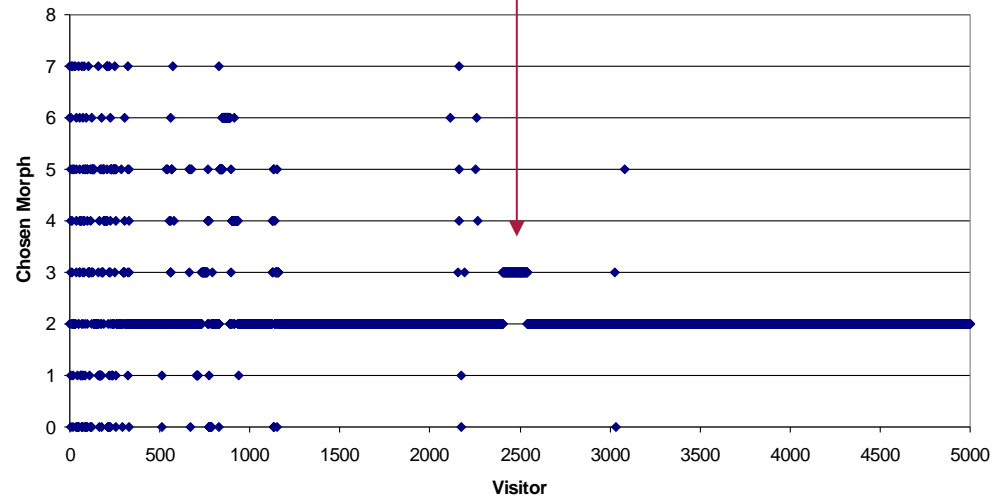


Gittins' indices for the eight morphs.

System experiments with Morph 3 for a while before settling back to Morph 2.



Morph that was chosen.



# Morphing Trilogy

- **What is the cognitive style of the current user?**
    - Update our beliefs as new clicks become available
  - **What is the optimal morph for each style?**
    - Update as we observe successes and failures
  - **How to handle repeat visits and cumulative learning ?**
    - Field experiment on cnet.com w/ AT&T banner ads
    - Roll-back mechanism
  - **Generalized Morphing Algorithm: w/ When to Morph**
    - DP solves trade-off between gains from morphing **early** (longer exposure) and gains from morphing **later** (better knowledge)
    - Exposure to **multiple morphs**
      - **Attribution** problem: recency, exposure, both
      - **Switching costs**: changing morphs only if expected rewards exceed penalty for switching
- Website Morphing (2009)
- Morphing Banner Advertising (2014)
- Website Morphing 2.0 (2014)

# Morphing in the Field

- **Can be used normatively (e.g., field experiments) or descriptively (secondary data)**
- **Two tuning parameters makes it flexible to various applications**
  - Switching costs
  - Different attribution theories/regimes
- **Morphing is appropriate to contexts with**
  - High volume of observations
  - Clear success/failure outcome
  - Latent variable

# Laboratory on Optimization of Digital Experiments (LODE) @ Erasmus University

- Executive education course on Digital Experimentation and Big Data
- **Research Fridays:** Bi-monthly meetings of academics and founding companies at Erasmus University
- Bi-yearly publication of **research priorities** for research on A/B testing
- Erasmus students running A/B testing & morphing with real-world company traffic
  - Module 1: Text-analysis methods
  - Module 2: A/B experiments
  - Module 3: Morphing

# References

- Hauser JR, Urban GL, Liberali G, Braun M (2009) **Website morphing**. *Marketing Sci.* 28(2):202–224.
- Urban G., Liberali G., MacDonald E., Bordley R., Hauser J. (2014) **Morphing Banner Advertising**, *Marketing Science*, 33(1): 27-46.
- Hauser J., Liberali G., Urban G. (Summer 2014) **Website Morphing 2.0: Switching Costs, Partial Exposure, Random Exit, and When to Morph**. *Management Science*.



# Thank you!

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- E-Mail Newsletter Design
- Exclude mvvisits from Google Analytics

Research by M... website, then c... achieved in 10... summaries, in... whether it be t... Hauser Urban

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